Macroinvertebrate Sampling Using a Dredge Net in a Farm Dam in Southwestern New South Wales

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ABSTRACT

The number of samples required to quantitatively sample the macroinvertebrates in 0.05 ha farm dam in southwestern New South Wales using a dredge net was investigated. Twenty samples, each from a 15 m x 0.46 m area of the dam floor, were collected. The numerically dominant species showed contagious distributions, and the distribution of the community was not influenced by wind or submerged terrestrial grass. In the dam studied, 8 samples would have given an estimate of the true mean number of macroinvertebrates per sample with 95 percent confidence limits and 40 percent accuracy.

INTRODUCTION

Farm dams are the most common lentic water bodies in Australia (Weatherley, 1967), and are comparatively simple ecosystems in which biological diversity may be low (Timms, 1980). Although such environments are favourable for quantitative study of species abundance, diversity and succession, little work has been conducted on the fauna of farm dams in Australia (Bayly and Williams, 1973). In a review of the ecology of farm dams, Timms (1980) concluded that for macroinvertebrates little more than species lists are available and that they are often difficult to interpret.

Several sampling methods have been employed in studying macroinvertebrates in farm dams. Croxford (1977) took sweep samples in open water, and entrapped animals associated with vegetation in a metal tube pushed vertically into the substrate. Walker (1974) used a sweep net in open water and among macrophytes, and a modified Macan-type sampler in vegetation growing from the dam edge into the water. A similar device was used by Weatherley and Nicholls (1955) for collecting epiphytic fauna. These authors were primarily interested in the qualitative aspects of their collections.

A small beam trawl used for collecting surface and bottom living animals was described by Ruello (1975). He gave a list of animals taken from inland waters of New South Wales, and reported that the beam trawl could be used for quantitative sampling of yabbies *Cherax destructor* in dams.

A sampling method which provides comparable data between sites and sampling times would enhance the value of data collected in studies on farm dams. Macan (1949) and Crisp (1962) showed that sweep nets were more satisfactory than hand grab-samplers or traps for sampling active free-swimming insects. A dredge net (Welch, 1948; Williams, 1980), which is similar to the beam trawl of Ruello (1975), operates on the same principle as a sweep net but allows a greater area to be sampled with less effort.

In the present study we used a dredge net to sample macroinvertebrates in a farm dam, in order to examine the distribution of individual taxa and the distributional homogeneity of community structure with respect to submerged grass and wind, and to determine the number of samples required to estimate the true mean with varying confidence intervals and degrees of precision.

MATERIALS AND METHODS

The dam was situated in southwestern New South Wales (34°56.2′S, 146°25.0′E). The geological origin of the area is Middle Ordovician, and the soils formed in the region are red earths (Northcote classification Gn2.11-3/2/15) (Crouch, 1974). The dam was rectangular, 26 m long, 19 m wide (surface area 0.05 ha) and 1.9 m at the deepest point. The walls had a 1:3 slope. The long axis of the dam was oriented east-west, and water runoff entered the dam from the eastern side. The substrate was clay, and suspended clay colloids caused the water to be very turbid (Secchi disc depth of 100 mm). The dam was devoid of vegetation, although seed-heads of the terrestrial "blown-grass" *Agrostis avenacea* had accumulated and submerged in the northeast corner. Sampling was conducted on 17 December 1979, between 1300 and 1500 hours, at which time the weather was fine and cloudy with a 12 to 18 knot wind from the northwest.

The dredge net (Fig. 1) was made of a 500 μm mesh net. The open end was 460 mm x 310 mm, and the net tapered for 1 m to a collecting jar 60 mm in diameter. The net was supported 60 mm off the substrate by a frame attached to a ski on each side. A "kick chain" joined the two skis 170 mm in front of the mouth of the net.

A total of twenty samples, five from each side of the dam, was collected. For practical reasons, sampling was from the western, northern, eastern and southern banks respectively. The dredge net was released either from a boat or by wading out from the opposite bank from which it was being towed, and then towing it over 15 m of the dam floor at approximately 1 m/sec. The five tows from each bank were spaced along the length of the bank, and care was taken

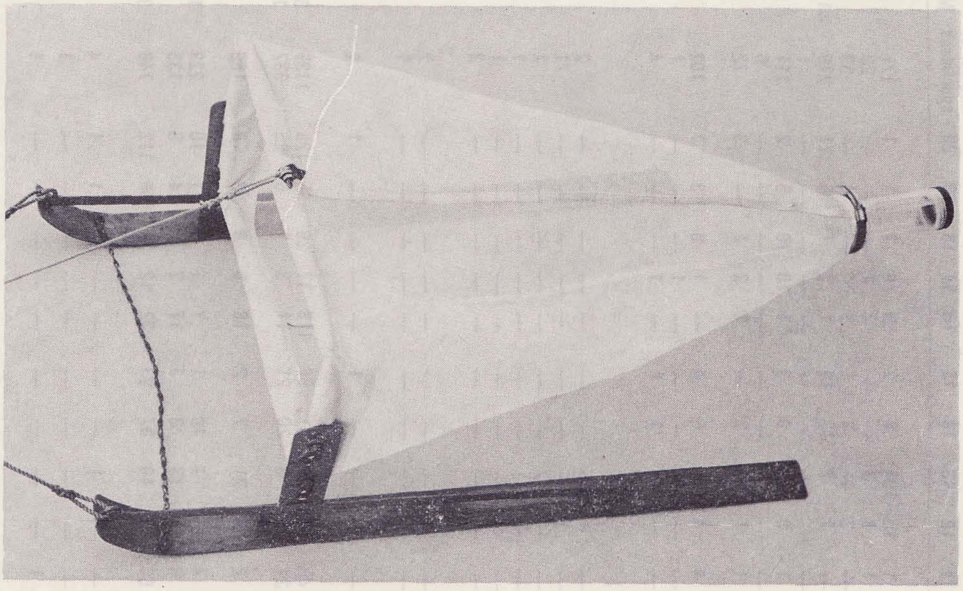

Fig. 1. Dredge net used for sampling macroinvertebrates.

to stagger each sampling position so as to avoid covering a path taken by a tow from the opposite bank. The samples were preserved in 70 per cent alcohol.

Although the north and south samples ran parallel to each other in the middle of the dam, most of the animals would have come from the last part of the tow where the samples were effectively separated, because insects are generally more common in the shallower sections than in the deeper sections of dams (Barlow, pers. obs.). The experimental design meant that some of the later samples intersected the paths of earlier samples, but it was considered that this would not have seriously influenced the number of macroinvertebrates collected.

In the laboratory the samples were sorted to the lowest taxonomic level possible and counted. The effect of submerged grass (samples 9 to 13) and wind (samples 13 to 17) on the distribution of the community was examined using N (the total number of animals), S (the total number of taxa) and E (Heip's evenness). The distribution of the community was also examined using SAHN (sequential agglomerative hierarchical non-overlapping clustering programme) of the TAXON package (CSIRONET system). The data were then analysed to determine the number of samples required to estimate the true mean number of animals per sample with varying confidence intervals and degrees of precision. Statistical tests were conducted at the 5% level of significance.

TABLE 1. Numbers and types of macroinvertebrates in twenty samples collected with a dredge net in a farm dam in south-western New South Wales.

Dam bank orientation	West					North					East					South					Total number of specimens	Mean	Variance
Sample number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
Dytiscidae																							
Allodessus bistrigatus (Clark)	5	2	2	—	13	—	1	—	—	2	1	10	104	8	2	6	6	7	1	1	171	8.55	518.58
Liodessus shuckhardi (Elk)	1	2	—	—	7	1	—	—	—	2	1	3	3	—	—	2	1	—	—	—	23	1.15	2.98
Megaporus honitti (Clark)	—	—	2	1	1	—	5	4	2	1	—	2	—	3	1	3	4	—	4	—	33	1.65	2.77
Antiporus gilberti (Clark)	17	20	7	16	34	18	7	9	7	4	—	7	2	13	18	1	2	1	15	21	219	10.95	78.37
Antiporus femoralis (Boh)	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1		
Eretes australis (Erichson)	—	9	14	10	—	—	5	7	14	1	1	8	3	8	3	1	10	10	5	2	111	5.55	21.52
Homoeodytes scutellaris (Germ)	—	—	1	1	—	—	—	1	2	—	—	—	—	—	—	—	—	—	—	—	5		
Sternopriscus multimaculatus (Elk)	4	1	—	—	5	1	2	—	—	1	1	1	46	2	—	2	2	1	—	3	72	3.60	101.52
Necterosoma wallastoni (Clark)	—	14	8	4	3	1	8	8	13	—	4	4	9	5	4	—	1	6	3	7	102	5.10	16.41
Rhantus suturalis (Mael)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1		
Hyphydrus eleganus (Montrouzier)	—	—	—	1	—	—	—	—	—	—	—	—	—	1	1	—	1	—	—	—	4		
Hydrophilidae																							
Helochares sp.	—	—	—	—	—	—	—	1	—	—	—	1	—	—	—	—	—	—	—	—	2		
Spercheus sp.	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1		
Berosus sp. a	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	2		
Berosus sp. b	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	1		
Berosus sp. c	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	1		
(Specimens lost)	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2		
Hydraenidae																							
Ochthebius sp.	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2		
Hydraena sp.	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1		
Helminthidae																							
Coxelmis V-fasciata Lea	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	2		
Corixidae																							
Sigara sp.	48	42	42	8	62	89	46	16	13	140	46	51	113	31	66	113	17	29	35	128	1135	56.75	1563.25
Agraptocorixa parabiopunctata (Hale)	37	7	15	12	38	26	21	12	5	45	21	6	6	20	21	11	3	1	5	25	337	16.85	157.82
Agraptocorixa eurynome (Kirkaldy)	2	3	4	4	12	4	6	5	4	37	2	14	21	7	2	18	5	8	3	8	169	8.45	73.84
Micronecta annae group	2	43	12	4	11	6	33	—	2	33	4	25	7	16	1	7	1	5	1	10	223	11.15	157.29
Nymphs	—	8	10	2	6	4	6	6	2	19	9	9	13	3	3	17	2	3	4	9	135	6.75	25.99
Notonectidae	53	10	7	16	29	30	15	15	29	74	50	17	40	37	93	32	12	17	58	112	746	37.30	824.64
Nepidae																							
Ranatra dispar Montandon	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—	—	—	—	1	1	4		
Diptera larva	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1		
Trichoptera larva	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1		
Parastacidae																							
Cherax destructor Clark	4	2	—	2	4	3	2	1	2	5	4	11	2	5	9	12	—	—	1	4	73	3.65	11.82
Total number of individuals	173	164	124	81	225	188	159	86	95	364	145	170	373	169	225	225	68	88	136	332	3580	179.0	8146.42

RESULTS

The types and numbers of animals collected in each sample are listed in Table 1. The total number collected per sample did not diminish as sampling progressed, which justified our assumption in the experimental design that later samples would not have been influenced by their paths intersecting the paths of earlier samples. The variance was greater than the mean for all groups, indicating that a contagious (or clumped) distribution was shown by each group (Elliot, 1977). Clumped invertebrate populations are often described by the negative binomial model (Elliot, 1977). Consequently, chi-squared tests for goodness-of-fit of this model were conducted for the numerically dominant groups (*Antiporus gilberti, Sigara* sp., *Agraptocorixa parabiopunctata, Micronecta annae* group and Notonectidae) and for the total number of individuals in each sample. In all cases the χ^2 values were not significant (Table 2); thus the distributions did conform to the negative binomial model.

TABLE 2. The mean ($\hat{\mu}$) and dispersion parameter ($\hat{\kappa}$) of the negative binomial distribution and χ^2 values for goodness-of-fit tests for the numerically dominant groups and for the total number of individuals in each sample, estimated by maximum likelihood methods using MLP © 1978 Lawes Experimental Trust, CSIRONET system. (The data had to be grouped because zero-frequency cells were not permitted in the programme; this resulted in different numbers of groups for each species and thus different degrees of freedom).

	$\hat{\mu}$	$\hat{\kappa}$	χ^2	d.f.
Antiporus gilberti	11.31	1.22	6.26	6
Sigara sp.	56.77	1.89	4.35	3
Agraptocorixa parabiopunctata	17.80	1.68	5.22	4
Micronecta annae group	11.17	0.85	3.58	4
Notonectidae	33.92	2.16	1.38	5
Total number	173.47	4.10	8.46	9

The means, standard deviations and Mann-Whitney U-test statistics (Elliot, 1977) of N, S and E for the comparisons of grass-affected samples and wind-affected samples with control samples are given in Table 3. The U-statistics were not significant in any of the comparisons, which indicated that the distribution of the community was not influenced by submerged terrestrial grass or wind. This was confirmed by analysis of the data in Table 1 using SAHN, which did not reveal any obvious patterns of community distribution.

The minimum number of samples required to define the mean number of animals per sample was calculated using the formula of Elliot (1977);

$$N = \frac{t^2}{a^2}\left[\frac{1}{\bar{x}} + \frac{1}{\hat{\kappa}}\right]$$

where N is the number of samples required, t is Student's t value for n-1 degrees of freedom for a given confidence interval, a is the accuracy desired in describing the mean, $\bar{x}$ is the mean of n samples, and $\hat{k}$ is the dispersion parameter of the negative binomial estimated from:

$$\hat{k} = \frac{\bar{x}^2 - s^2/n}{s^2 - \bar{x}}$$

where s^2 is the variance of n samples. The values of N obtained using the information from Tabe 1 ($\bar{x} = 179.00$, $n = 20$, $\hat{k} = 3.97$) with various levels of accuracy and confidence intervals are given in Table 4.

TABLE 3. Means (± standard deviations) and Mann-Whitney U-test statistics of N (total number of animals), S (total number of taxa) and E (Heip's evenness), for the comparison of grass and control samples and wind and control samples. (Tabulated value of U at the 5% level of significance is 14 for $n_1 = 5$ and $n_2 = 15$; that is, a U-value less than 14 would be significant (Elliot, 1977)).

Parameter	Mean (± s.d.)	U_1	Mean (± s.d.)	U_2
	Grass		Control	
N	229.4 (±129.9)	49	162.2 (±70.91)	26
S	14.0 (±1.87)	44	13.2 (±1.37)	32
E	0.477 (±0.121)	32	0.521 (±0.137)	43
	Wind		Control	
N	210.0 (±111.6)	28	168.7 (±83.92)	48
S	14.4 (±1.14)	58	13.1 (±1.49)	17
E	0.471 (±0.151)	32	0.522 (±0.128)	44

TABLE 4. The number of samples required to estimate the true mean number of macroinvertebrates per sample in a farm dam with various levels of accuracy and confidence intervals

Confidence interval	Number of samples		
	Accuracy		
	± 20%	± 30%	± 40%
80%	12	6	3
90%	20	9	5
95%	29	13	8

DISCUSSION

A quantitative investigation of macroinvertebrate populations raises the problem of finding a suitable sampling technique. If the study concentrates on a single species, the sampling device most effective at catching that organism can be chosen. However, if the complete faunal assemblage is under investigation the sampling method chosen is a compromise, because the ability of different species to escape the sampling device varies. Consequently, interpretation of Table

1 is qualified by the ability of the different species to escape the dredge net. It follows that the data can not be used to determine absolute numbers of animals living on or above the substrate.

A contagious distribution is frequently seen in animal populations, because many environmental factors are unevenly distributed, and because some species have a tendency to aggregate and produce a contagious distribution without the influence of environmental factors (Elliot, 1977). In this study, neither wind nor the presence of submerged terrestrial grass appeared to influence the distribution of the macroinvertebrate community, which implies that these factors can be ignored when sampling similar dams with a dredge net. However, Crisp (1962) and Savage (1979) have suggested that the distribution of corixids in the littoral zone may be affected by wave action.

Elliot (1977) suggested that 95 per cent confidence limits and 40 per cent accuracy were acceptable in estimating the mean of benthic populations. In the present dam 8 samples would have given this result (Table 4). The number of samples required varies with the density of animals. As the study dam contained about an average number of insects for similar dams in the same region (Barlow, pers. obs.), it is suggested that when using a dredge net between 5 and 10 samples should be taken to obtain a statistically valid estimation of the mean number of animals per sample in these dams.

Qualitative sampling with plankton nets and an Ekman dredge did not reveal other macroinvertebrates than those retained by the dredge net. The dredge net can also be used in dams containing macrophytes by removing the kick chain and attaching a rake to direct weed under the net (Topp, 1967). Consequently, we conclude that the dredge net is probably the most suitable device for sampling macroinvertebrates living on or above the substrate in farm dams.

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